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Art. XVIII.—*Mineral Resources of Southern India.—No. 2. Magnesite Formations*[1]. *By* Lieut. Newbold, F.R.S. &c.

(*Read March* 19, 1842.)

Although it is the object of this paper to notice all the known magnesite localities of Southern India, its scope is more particularly directed to that of the Salem province, as being the most extensive, and as yielding the mineral in the greatest abundance.

Geographical position.—The magnesite formation of Salem lies about 4 or 5 miles to the N. W. of the town of that name, which is situate in Lat. 11° 37′ N. and Long. 78° 13′ E.; it occupies an area, the longest diameter of which runs east and west, of about 8 square miles.

Geognostic position.—The surrounding formation consists of a series of alternating hypogene schists;—gneiss, mica, hornblende, and talcose, associated with granite, and a rock analogous to serpentine, and penetrated by dykes of basaltic greenstone.

The magnesite is chiefly found in the hornblende schist, in veins from a few lines to three feet in thickness: the larger surface veins usually run almost horizontally, having a general direction of E. 15. S. and intersected by others, having a vertical, or highly inclined course. At considerable depth below the surface, the largest veins are nearly vertical, dipping southerly: their ramifications strongly resemble those of basaltic dykes. The veins commonly diminish in breadth as they ascend, or are prolonged in the countless fissures, into which the embedding rock appears to have been shattered by a force anterior to the formation of the veins. Some of the fissures are broader than the vein of magnesite with which they communicate.

Near the N. limit of the magensite area, the rocks rise but slightly from the general level of the plain; towards the S. E. they are elevated from 50 to 150 feet above the level of the surrounding country, in chains of hills partially covered with low jungle, and running in an E. and W. direction near the base of the Shevaroy mountains, of which they form subordinate ranges. On the sides of these hills, and those of the ravines intersecting them, the veins of magnesite are strikingly conspicuous, their white colour being powerfully contrasted with the dark rugged aspect of the embedding dioritic rocks. Advancing northerly, nearly at right angles with the line of elevation, three large veins of magnesite are crossed, which disappear in the hilly and jungly tracts to the right and left. The two most northerly veins are separated by a zone of massive crystalline amphibolite, intersected by a rock analogous to serpentine, and succeeded by a bed of massive talcose rock. Here the surface presents the aspect of a plain, or rather of a broad shallow valley, bounded by low ranges of the hypogene schists in highly inclined strata. The harder hornblende rocks are found to stand out in relief, while the softer schists, from weathering more rapidly, are usually found in the bottoms of the valleys. The veins of magnesite are particularly numerous in this locality, and exhibit a great tendency to metalline development, being associated with large veins, and containing embedded masses of the chromate of iron. The talcose rock near the contact line becomes indurated, and passes into a light green serpentine,—mottled with reddish, blackish, and dark green spots,—between which and the veins, a thin coat of asbestus, both white and green, passing into nephrite, usually intervenes. The hornblende rock, near the veins, assumes the appearance of weathered serpentine, becoming mottled, and lighter in colour. Drusy cavities are seen in it, lined with a botryoidal, and semicrystalline carbonate of magnesia,—often beautifully white and pure.

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[1] A section of these veins will be given in the next paper on the mines of chromate of iron, a mineral with which the magnesite is associated.

The mode in which these cavities, and the sides of the cracks in the rocks are incrusted with crystallized carbonate of magnesia, suggests the hypothesis of the mineral's having been conveyed into them by a process of sublimation from below;—a theory rendered more plausible by the fact of the presence of numerous basaltic dykes in the vicinity. Springs impregnated with carbonate of lime and a small portion of iron, rise through the empty fissures of the rocks, and deposit on their surface, pale reddish incrustations of compact carbonate of lime, resembling the travertine of the volcanic districts of Italy, and not unfrequently cementing together fragments of the magnesite, and forming with them, and pieces of the subjacent rocks, a singular looking breccia. A spring, slightly thermal, having a temperature of 84° Fahr., bubbles up at the base of one of the ridges.

Mineral character of the Magnesite.—The air-exposed surface of the magnesite has generally a dirty white aspect, and is either nodular, botryoidal, mammillary, rough and scabrous, or separated by numerous fissures into a cauliflower-like superficies. Some very pure varieties are translucent, and have a stalactiform exterior:—

others present a fibrous structure :—some a radiated one : a few present a chalky friable interior, white as snow : but the general character of the mineral, in the massive state, is that of a hard white travertine :—in colour varying from pure white to buff :—fracture, flat conchoidal; fragments sharp, translucent at edges :—adheres feebly to the tongue :—streak, dull :—feel, meagre :—softer than quartz in general, though sometimes hard enough to give fire with steel :—before the blow-pipe it shrinks, whitens, and hardens : with dilute mineral acids it effervesces slightly : specific gravity, from 2·897 to 2·970 at a temperature of 85°.[1] It is obtained in minute transparent hexagonal prisms with three equivalents of water, when a solution of bi-carbonate of magnesia evaporates spontaneously in an open vessel. The crystals lose their water, and become opaque by a very gentle heat, and even in a dry air at 60°. By cold water they are decomposed, yielding a soluble bi-carbonate, and an insoluble white compound of hydrate and carbonate of magnesia; and hot water produces the same change with disengagement of carbonic acid, without dissolving any magnesia.[2] When calcined and powdered, and mingled in the proportion of two parts (by measure) with one part of sharp quartz sand, the magnesite makes an excellent cement. During calcination, it often separates into curling, fibrous flakes; shows great affinity for water after calcination, and forms, *per se*, a firm cement. A foot or two below the surface of the soil, when recently cut into, it is often soft and sectile, like laterite; but hardens rapidly on exposure to the atmosphere. Some quarried fragments, which I observed under the water-mark at the bottom of the chrome mines, were as compact, white, and hard as the finest porcelain. Mr. Fischer, of Salem, informed me that he had often observed, during the night, a pale phosphorescent light playing over the surface of the magnesite at the bottom of the shallow excavations, which in the darkness imparts a strange unearthly aspect to the spot, well calculated to excite the alarm of the superstitious natives.

According to the analysis of Mr. J. Prinsep, the magnesite of Salem assimilates the character of a pure carbonate of magnesia, more than the mineral of Hroubschitz in Moravia, analysed by Bucholz : as will appear below.

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[1] Journal As. Soc. of Bengal, No. 45, p. 510. Henry makes its spec. grav. 2·56, and describes it as a pure anhydrous carb. of magnesia, of snow-white colour, and hard enough to give fire with steel. (An. of Phil. XVII. 252.)

[2] Turner's Elements of Chemistry, p. 738.

	Magnesite of Hroubschitz.	*Magnesite of Salem.*
Magnesia	46	48·34
Carbonic acid	51	51·66
Alumina	1	a trace
Ferruginous manganese	0·25	a trace of iron
Lime	0·16	0·0
Water	1	0·80
Silica	,,	0·30

According to Phillips,[1] a mineral was brought some time ago from India, under the name of native carbonate of magnesia in the form of a light powder, or in small rounded lumps nearly white, or slightly tinged with yellow. It adheres to the tongue,—the fracture very earthy, resembling chalk. Dr. Thomson found it to be composed of carbonate of magnesia 72, carbonate of lime 28. This mineral is widely different from that of Salem; but resembles one which I discovered associated with woody asbestus in the magnesian limestone of Ryelcherroo in the Ceded Districts.

A. Brogniart thus classifies the magnesites of Europe.[2]

"1. Plastic magnesite (magnésite plastique,) composed of magnesia, silex and water, without carbonic acid. These comprise the magnesite so improperly named écume de mer, that of the environs of Madrid, that of the environs of Paris, that of Salinelle, department of the Gard, &c."

"2. Effervescent magnesite (magnésite effervescente,) essentially composed of magnesia and carbonic acid, sometimes associated with very variable proportions of silex and water. We may refer to this division the magnesite of Hroubschitz in Moravia: those of Piedmont, of the isle of Elba, of Baumgarten in Silesia, of Styria, &c."

Mineralogically speaking, the Salem magnesite resembles the second of these classes more than the first; but differs from both in being both plastic and effervescent: it contains less water, alumina, and ferruginous matter than the second, and no lime, except from accidental admixture.

Geological age of the Salem Magnesite.—The Salem magnesite belongs to an older formation than those of Madrid, Paris, &c., which occur in secondary limestones; and seems to assimilate those of Styria, Moravia, Turin, and Baltimore in North America; all of which occur in hypogene rocks, and serpentines associated with them. The magnesite of Baltimore, and New Jersey, is sometimes associated with chromate of iron, like that of Salem. Chert passing into calcedony is also occasionally found associated with the magnesite of Salem, and of Hoonsoor in Mysore.

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[1] Introduction to Mineralogy, 2nd ed. p. 138.

[2] Geological Memoirs, translated by De la Beche, p. 283.

Concluding Remarks.—Dr. Heyne was the first to discover the magnesite formation of Salem, and Dr. Macleod of the Madras service, to bring to notice the useful properties of the mineral in the composition of cements. The latter gave me the following account of his discovery. "Having had a small building to construct, in the interior of which lime was inadmissible, I was induced to make trial of a cement composed of the magnesite: I found that it set very durably, and in five or six days acquired all the properties of a good cement: a few patches of it were applied to the fort of Madras in February, 1825." About a year afterwards, Colonel Sim of the Engineers, reported officially to Government on trials made with it at the fort. He stated that a cement composed of the calcined magnesite and sand (by measure two parts of the former to one of the latter) was applied to the counterscarp of the ditch of Fort St. George, and a portion of the same wall was plastered with a cement of lime and powdered iron stone, leaving an intermediate space of ten feet, which was covered with common chunam plaster. These were exposed to a heavy monsoon, when the magnesian cement was found to be rather the strongest and hardest of the three; and seemed equal, as far as a judgment could then be formed, in every respect to Parker's cement. The expense was equal to that of Parker's cement:—a ton of either, when brought to Madras, after being calcined, and reduced to powder, costing from 80 to 90 rupees:—but Dr. Macleod subsequently stated to Government (Letter to Sir F. Adam, 1st October, 1835) that the magnesite had since been found in large quantities (at Yedichicolum?) near Trichinopoly on the banks of the Cauvery, and could be conveyed to Madras, calcined, at about 40 rupees per ton;—which, with 1½ ton of sand added to it, would be equivalent to 2½ tons of Parker's cement,—the price of which is about 200 rupees. The last mentioned proportions of sand and magnesite were employed by Colonel Monteith of the Madras Engineers, and, to use that able officer's expression, they formed a cement as firm as a rock.

A few years ago, Colonel Pasley, not being aware that the discovery of this valuable hydraulic cement had been brought to the notice of the Madras Government by Dr. Macleod, so far back as 1825, submitted his own claims to the discovery, to the Indian home authorities; who, on investigation, having ascertained the priority of Dr. Macleod's pretensions, munificently presented the latter with the sum of 3,000 rupees.

Besides the localities mentioned in the course of this paper, magnesite occurs, according to information afforded me by natives, in the vicinity of Comarpollium, about 12 miles westerly from Sankerry-droog in the Salem district, and in the copper mine district of Nellore: it has also been discovered by Mr. Gilchrist in the neighbourhood of Hoonsoor in Mysore. It occurs like that of Salem, and Trichinopoly, in all these localities, in the hypogenic schists, particularly the hornblende schist, and associated with asbestus, chert, nephrite, and sometimes with the chromate of iron.